# The Role of Pelvic fractures in the Course of Treatment and Outcome of Trauma Patients

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**Key words:** pelvic fracture, trauma, treatment

## Abstract

**Background:** Pelvic fracture poses a complex challenge to the trauma surgeon. It is associated with head, thoracic and abdominal injuries. As pelvic fracture severity increases so does the number of associated injuries and the mortality rate.

**Objectives:** To report our experience in the treatment of pelvic fractures.

**Methods:** Between October 1998 and September 2001, 78 patients with pelvic fractures were admitted to our hospital. The age range of the 56 male and 22 female patients was 16–92 (mean 42 years). The cause of injury was road accident in 52 patients, fall from a height in 15, a simple fall in 9, and gunshot wounds in 2 patients. The Glascow Coma Scale score on arrival at the hospital was 3–15 (average 12). Twenty-five patients (32%) were admitted to the intensive care unit, 38 (48%) to the orthopedic department, 5 (6.4%) to neurosurgery and the remainder to a surgical department.

**Results:** Twenty-six patients (33.3%) received blood transfusion in the first 24 hours. Of the 25 patients with associated head trauma, 6 had intracranial bleeding (32%); 29 patients (37%) had associated chest trauma, 28 (35.9%) had associated abdominal trauma, 16 (20.5%) had vertebral fractures and 40 (51.2%) had associated limb fractures. Pelvic angiography was performed in 5 patients (6.4%), and computed tomography-angiography of the cervical arteries and chest was performed in 1 and 5 patients respectively. Overall, a CT scan was performed in 56 patients (71.8%), of whom 25 (32%) had a pelvic CT on admission. Injury Severity Score was 4–66 (median 20). Laparotomy was performed in 14 patients (18%), spinal fusion in 5 (6.4%), limb surgery in 16 (20.5%), cranial surgery in 4 (5.02%), pelvic surgery in 10 (12.8%), chest surgery in 3 (3.85%), and facial surgery in 2 patients (2.56%). Seven patients (9%) died during the course of treatment.

**Conclusions:** Pelvic fracture carries a high morbidity rate. Associated chest, abdomen and limb injuries are often encountered. A multidisciplinary approach is needed to improve survival and outcome in patients with pelvic fractures.

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Trauma is one of the leading causes of death in the male population under the age of 40 and is responsible for the loss of more years of life than cancer and cardiovascular diseases together [1]. Among trauma patients requiring hospital admission approximately 5% have pelvic fractures [2], and of these patients 5–16% die [3–9]. Visceral hemorrhage is the principal cause of death during the first 4 hours after trauma [10]. Rupture of a main pelvic artery carries a mortality of 50–75%, and the main cause of death from pelvic trauma is arterial hemorrhage [11]. The major determinant of mortality in patients with pelvic fracture is the presence of shock with persistent resuscitation requirements; patients with an unstable fracture pattern and hemoperitoneum have the highest mortality [12]. Pelvic fracture poses a complex challenge to the trauma surgeon since it is often associated with head, thoracic and abdominal injuries. As pelvic fracture severity increases so does the number of associated injuries, transfusion requirements and mortality rate. We report our experience in the treatment of pelvic fractures.

## Patients and Methods

Patients diagnosed with a pelvic fracture who were admitted to the trauma center at Rabin Medical Center (Beilinson Campus) during a 3 year period (October 1998 to September 2001) were identified from the trauma registry. The medical records were reviewed for patient demographics, mechanism of injury, associated injuries, hemodynamic status, Injury Severity Score, blood transfusion requirement, hospital length of stay, and mortality.

The age range of the 78 patients (56 males, 22 females) with pelvic fractures admitted to our hospital was 16–92 (mean 42 years). The mechanism of injury was road accident in 52 (15 pedestrians, 5 motorcyclists, 25 car passengers/drivers), fall from a height in 15, a simple fall in 9, and gunshot wounds in 2 [Fig-

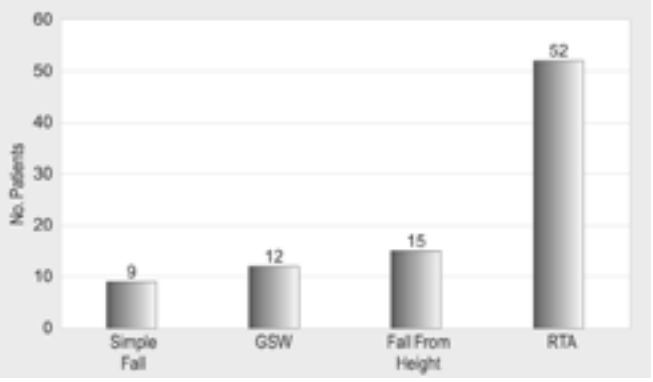


**Figure 1.** Mechanism of injury.
GSW = gunshot wounds, RTA = road traffic accident.

ure 1]. Twenty-five patients (32%) were admitted to the ICU, 38 (49%) to the orthopedic department, 5 (6%) to neurosurgery and the remainder to a general surgical department.

## Results

The pelvic fractures were classified according to the Young classification; rami pubis fractures, acetabular fractures and iliac fractures were also noted [Table 1]. The Glascow Coma Scale on arrival at the hospital was 3–15 (average 12). Twenty-six patients (33.3%) received blood transfusion in the first 24 hours. Of the 25 patients (32%) with associated head trauma 6 had intracranial bleeding. In addition, 29 patients (37%) had associated chest trauma, 28 (35.9%) had associated abdominal trauma, 16 (20.5%) had vertebral fractures, and 40 (51.2%) had associated limb fractures of whom 17 (21.8%) had multiple fractures and 8 (0.25%) had facial bone fractures [Table 2].

Pelvic angiography was performed in 5 patients (6.4%) and computed tomography-angiography of the cervical arteries and chest was done in 1 and 5 patients respectively. Overall, 56 patients (71.8%) had a CT scan, of whom 25 (32%) had a pelvic CT performed on admission. ISS score was 4–66 (median 20).

With regard to surgical procedures, laparotomy was done in 14 patients (18%), spinal fusion in 5 (6.4%), orthopedic limb operations in 16 (20.5%), cranial surgery in 4 (5.02%), pelvic surgery in 10 (12.8%), chest surgery in 3 (3.85%) and facial surgery in 2 (2.56%). Seven patients (9%) died during the course of treatment [Table 3].

**Table 1.** Type of pelvic fracture

| No. of patients | Type of pelvic fracture |
|---|---|
| 13 | Not available |
| 0 | Antero-posterior compression I |
| 1 | Antero-posterior compression II |
| 6 | Antero-posterior compression III (open book) |
| 7 | Lateral compression I |
| 2 | Lateral compression II |
| 0 | Lateral compression III |
| 1 | Vertical shear |
| 0 | Combined mechanical injury |
| 21 | Ramus pubis only (1–4 fractures) |
| 16 | Acetabulum |
| 5 | Ramus pubis + acetabulum |
| 6 | Iliac bone fractures, solitary |
| 78 | Total |

**Table 2.** Associated injury

| Associated injury | No. of patients |
|---|---|
| Head trauma | 25 (32%) |
| Chest trauma | 29 (37%) |
| Abdominal trauma | 28 (35.9%) |
| Vertebral fractures | 16 (20.5%) |
| Limb fractures | 40 (51.2%) |
| Facial bone fractures | 8 (0.25%) |

**Table 3.** Procedures

| Procedures | No. of patients |
|---|---|
| Laparotomy | 14 (18%) |
| Spinal fusion | 5 (6.4%) |
| Limb operations | 16 (20.5%) |
| Cranial operations | 4 (5.02%) |
| Pelvic operations | 10 (12.8%) |
| Chest operations | 3 (3.85%) |
| Facial operations | 2 (2,56%) |
| Mortality | 7 (9%) |

## Discussion

Pelvic fractures carry a high morbidity rate and associated injuries are often noted. Numerous authors have cited the incidence of pelvic fracture with associated brain injury to be 37–50%, associated thoracic injury 25–66%, and associated abdominal injury 42–51% [3,6,9,13,14]. Burgess et al. [3] and others [6,9] clearly demonstrate that as pelvic fracture severity increases, so does the number of associated injuries, transfusion requirements, and mortality rate. Starr and associates [15] suggest that the presence of shock on arrival, the Revised High Trauma Score, and patient age are more useful predictors of associated injury, injury severity, transfusion requirement, pelvic angiography requirement, and mortality – than fracture pattern alone.

Hemodynamically compromised patients with pelvic fractures present a complex challenge to the trauma surgeon. Vascular injury may result from laceration of a vessel by a bony fragment, laceration of a vessel as a direct consequence of external traumatic forces, and sudden distortion with shearing of vessels at their point of origin. An open surgical exploration to gain access to the retroperitoneum with an attempt to ligate the injured arteries is almost always ineffective. It may, on the other hand, aggravate the condition by disrupting the retroperitoneal tamponade and place the patient at a greater risk of dying of exsanguination [16].

Controversy remains regarding the optimal initial management of hypotensive patients with fracture of the pelvis. Some authors base the initial intervention on fracture pattern, with immediate external fixation aimed at controlling venous bleeding. Others believe that ongoing hemodynamic instability indicates arterial bleeding and they prefer early angiography [10]. Historically, surgical control of bleeding by direct ligation was attempted at the time of laparotomy, but the universally poor results [17] led to this method being abandoned.

Computed tomography largely contributes to management orientation of trauma victims [10]. Early use of dynamic helical CT scanning in the multiply injured patient with a pelvic fracture accurately identifies the need for emergent angiographic embolization [2]. A positive contrast extravasation test is extremely useful for predicting the need for embolization, with a

ICU = intensive care unit
ISS = Injury Severity Score

sensitivity of 84% and specificity of 85% for the detection of active retroperitoneal bleeding. The detection of contrast extravasation on CT scan can facilitate timely, life-saving pelvic angiographic embolization. Patients presenting with pelvic fractures, acetabular fractures, or both, who are candidates for investigation with CT scan should have intravenous contrast-enhanced scans. If contrast extravasation is seen on contrast-enhanced CT, the next step is urgent angiography [18].

External fixation remains one of the mainstays of pelvic fracture management. The framework provides skeletal stabilization, which aids in healing. In addition, it also plays a role in hemorrhage control [19]. External fixation reduces pelvic volume and, together with the blood clots, can place direct pressure on bleeding vessels to effect tamponade. Stabilizing the pelvis with an external fixator may also prevent repeated insult to the already clotted vessels. In contrast, those who disagree argue that external fixation may tamponade the low pressure venous hemorrhage but does not generate sufficient pressure to stop retroperitoneal arterial bleeding [20]. Furthermore, the stabilization of external fixation is said to be effective in pelvic fractures with undisrupted posterior structures but less so if the posterior structures have been disrupted [16]. While venous disruption is most common, arterial damage is more life- threatening. The arteries most frequently injured, in descending order, are the superior gluteal, internal pudendal, obturator, and lateral sacral arteries [21]. If patients present with hypotension from pelvic fracture, transient or no response to initial resuscitation indicates the presence of arterial bleeding in over 70% of patients, while adequate response to resuscitation makes arterial bleeding unlikely (negative predictive value of 100% in this series). In stable patients, contrast blush on CT also indicates a high likelihood of arterial injury and angiography should be pursued. With accurate assessment of the possibility of arterial injury, appropriate therapeutic choices can be made more easily [19].

Angiographic embolization for the control of pelvic arterial hemorrhage has been used in the management of hemorrhage from pelvic fractures for three decades [22] and its efficacy has been demonstrated repeatedly. Pelvic angiography and embolization of bleeding vessels have been recommended as having both a diagnostic and therapeutic role in the management of pelvic bleeding [23]. Transcatheter arterial embolization seems to work by stopping the arterial bleeding and allowing the tamponade effect of the hematoma to control venous bleeding. The success rate of TAE in experienced hands ranges from 85 to 100% [4,5]. Nevertheless, the mortality of patients undergoing embolization is still reported to be 27–47%. It had been claimed that the important factors in survival after TAE are age, time to achieve embolization, and initial hemodynamic instability [16]. Dondelinger and colleagues [10] noted an excellent overall correlation between CT and arteriography in demonstrating active bleeding; moreover, the combination of the two modalities enhances diagnostic capabilities. The timing of AE is important, although there are no scientific data attesting to the best time. Patients taken for early angiography may avoid dangerous delays and complications related to multiple blood transfusions, prolonged hemodynamic compromise, and extensive blood loss. However, by offering AE early during the course of the disease, it is possible that patients whose bleeding could be controlled by less aggressive means undergo an invasive procedure unnecessarily. On the other hand, if the primary attempt is to stabilize the patient by conventional resuscitation and intensive care before transport to the angiography suite, ongoing bleeding may lead to coagulopathy and acidosis, missing the opportunity for early effective angiographic control [24]. Despite aggressive resuscitation and successful TAE, patients who had rapid blood loss and therefore received rapid blood transfusion before TAE would have a poor final outcome. The risk of dying would have increased by 62% for every 1 unit/hour increase in transfusion rate. The effective clotting mechanism of a successful TAE could also be hindered by clotting factors depletion if patients received massive and rapid transfusion [16].

Following a radiologic survey and biomechanical study, Pennal et al. and Tile proposed a pelvic fracture classification system based on the direction of the injuring force: antero-posterior compression, lateral compression, and vertical shear. Young et al. refined the Pennal-Tile system, adding a fourth type, combined mechanical injury, and subdividing antero-posterior compression and lateral compression into three subtypes. Antero-posterior compression II and III, lateral compression III, vertical shear and combined mechanical injury are associated with disruption of major pelvic ligaments: the sacroiliac ligaments, sacrospinous ligament and sacrotuberous ligament. A significant relationship was shown between fracture patterns indicative of major ligament disruption and the need for pelvic embolization, but this relationship is not sufficiently strong to warrant angiography based on fracture pattern, even in patients with large transfusion requirements. Clinical assessment of cardiovascular instability, along with detection of a large pelvic hematoma or exclusion of other sources of hemorrhage, remain the best predictors of the need for pelvic embolization [22].

There are a number of drawbacks to angiography. It is a time-consuming procedure and involves the transportation of a severely injured patient to an angiography suite. In addition, it requires the availability of a skilled interventional radiologist. Since anatomic studies suggest that the bony surfaces of the fracture and veins are the main sources of hemorrhage, some feel that arteriography is rarely required [25]. Although varying algorithms for the initial management of bleeding pelvic fractures have been proposed, a key question in the decision-making process is whether arterial bleeding is present. If this question can be reliably answered, the subsequent management with early angiography falls into place. Controversy remains over the relative contribution and appropriate order of the two therapies to management of bleeding pelvic fractures. Given that each therapy addresses different sites of bleeding, initial treatment should optimally be aimed at the predominant source of

TAE = transcatheter arterial embolization
AE = arterial embolization

bleeding: arterial or venous. Arterial bleeding is known to occur in pelvic fracture patients both with and without initial hypotension [19]. It is clear that a multidisciplinary approach with special attention to potential vascular compromise is needed to improve patient survival and outcome. Special attention should be paid to elderly patients in whom these injuries are associated with a high mortality rate. An aggressive multidisciplinary approach to multi-trauma patients with pelvic fractures and potential vascular impairment will reduce the morbidity and mortality of patients with these types of devastating injuries.

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