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INSTRUCTIONAL LECTURE: TRAUMA

Immediate management of a stable patient with unstable pelvis

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- The diagnosis of a traumatic unstable pelvis in a stable patient is a temporary concept depending on when we see the patient, as all patients presenting with hemorrhagic shock have hemodynamic stability until they become unstable. As a rule, the more unstable the pelvic fracture is, the higher the risk of bleeding and hemodynamic instability it has. Therefore, in unstable pelvic fractures, hemodynamic stability should be a diagnosis by exclusion.
- For bleeding detection in stable patients, an immediate one-stage contrast-enhanced CT scan is the appropriate diagnosis test; however, since CT scan radiation is always an issue, X-rays should be considered in those cases of hemodynamically stable patients in whom there is a reasonable suspicion that no unsafe bleeding is going on. Pelvic fracture classification is essential as usually there is an association between the injury mechanism, the fracture displacement, and the hemodynamic stability. Anteroposterior and, particularly, vertical traumatisms have much more proclivity to provoke major pelvic displacement and bleeding.
- The use of a pelvic binder, as early as possible including pre-hospital management, should be standard in high-impact blunt trauma patients independently of the trauma mechanisms. External fixation is the preferred method of stabilization in case of open fractures, and, in closed ones, when the schedule for definite osteosynthesis prolongs because of the patient's general condition. If possible, immediate percutaneous sacroiliac screw insertion for unstable pelvic fractures produce excellent results even in open fractures.

Keywords: emergency; external fixation; hemodynamic; pelvic binder; pelvic CT scan; pelvic fracture; pelvic fracture classification; sacroiliac screw

Introduction

The concept of the traumatic unstable pelvis in a stable patient means that the pelvis has a displacement that may compromise its future stability with abnormal mobility and pain due to non-union, malunion, or dislocation; but that, by the time of admission in the emergency room, has not caused hemodynamic instability.

This concept, however, needs qualification for both the hemodynamics and the pelvic fracture. On the one hand, all patients presenting with hemorrhagic shock had hemodynamic stability until they became unstable; so hemodynamic stability is a temporary concept depending on when we see the patient. On the other hand, there are patients who did not have hemodynamic instability, but although their pelvic fractures might have consolidated without pathological movement, pelvic deformities with subsequent pain and dysfunction would develop.

As a rule, the more unstable the pelvic fracture is, the higher the risk of bleeding and hemodynamic

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instability it has. Therefore, in unstable pelvic fractures, hemodynamic stability should be a diagnosis by exclusion. Moreover, immediate treatment of pelvic fracture is always aimed not only to avoid pain and dysfunction but also to avoid further bleeding.

The objective of this instructional course review paper is to offer a clear strategy for the diagnosis and treatment of unstable pelvic fractures once it has been established that it is in the case of a hemodynamically stable patient (Fig. 1).

Pathomechanics

The pelvis is the bony structure composed of the two innominate (iliac) bones articulated posteriorly with the sacrum by an arthrodial synovial joint with robust ligaments, and anteriorly by an amphiarthrosis joint with potent fibrocartilage together with strong ligaments (Fig. 2). Thus, stability relies just upon the ligaments and the fibrocartilage, and not upon the joint shapes, as in diarthrosis joints does.

Although both the anterior (symphysis pubis) and posterior part (sacroiliac joint) preservation and alienation of the pelvis ring are equally important for adequate sitting and gait, the main pelvic stability relies on the posterior joint and its ligaments (1).

Posterior pelvic ligaments can be divided into two groups (Fig. 2): short (iliolumbar ligaments and sacroiliac – anterior and posterior – ligaments) and long ligaments (sacrosciatic and sacroischial). Their main function is to provide mechanical stability, but it is thought that they may also have a significant proprioceptive function (1).

Pure luxation of the pelvic bone is infrequent. In the case of posterior pelvis subluxation caused by lateral compression traumatism, posterior sacroiliac short

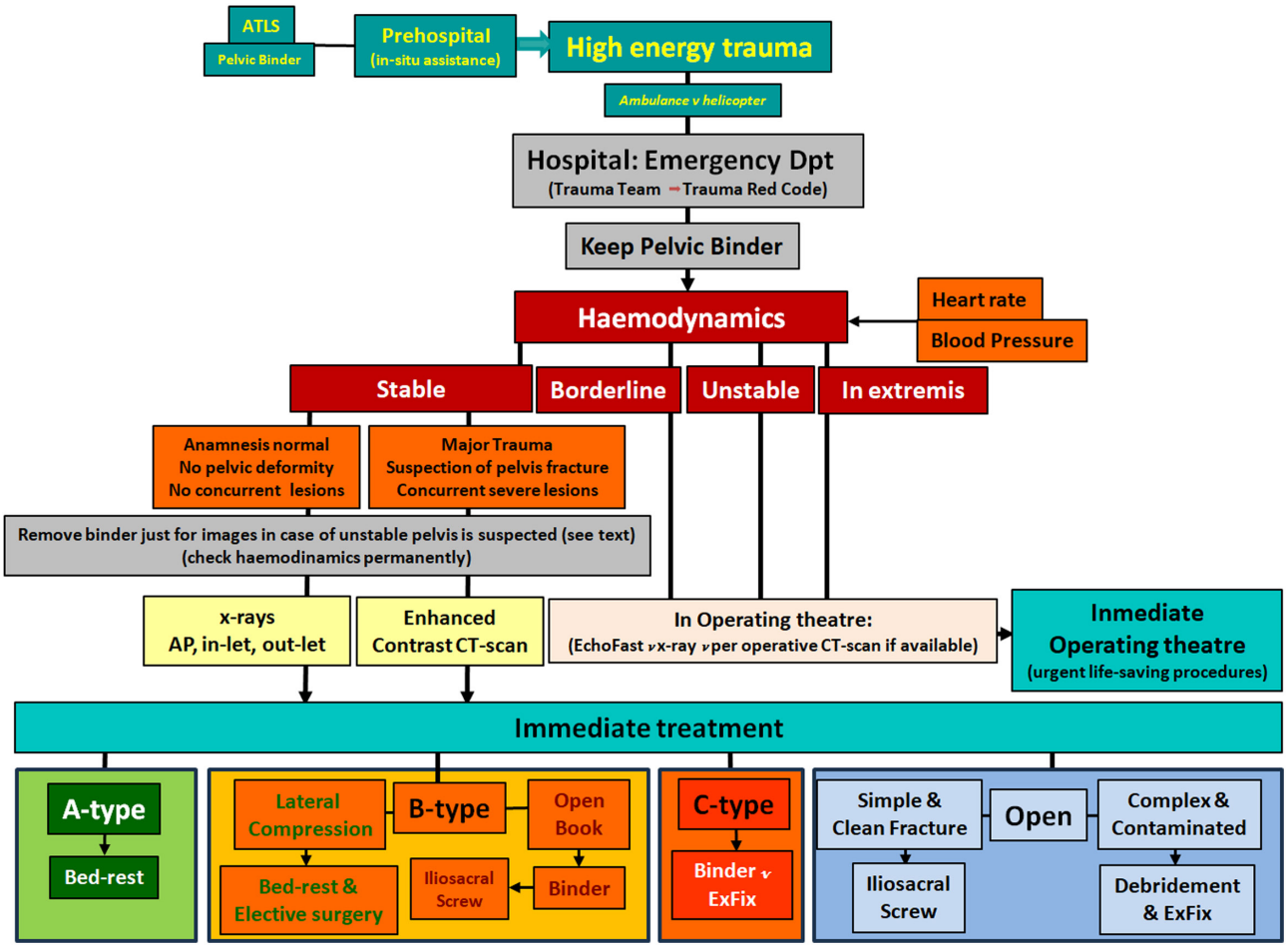

Figure 1

Algorithm of diagnosis and treatment in patients with pelvic fracture. Pre-hospital actions are of overwhelming importance, particularly ATLS. The pelvic binder is mandatory as clinical diagnosis of pelvic fracture does not have a very accurate value. The binder must be on throughout the diagnosis and transfer steps. Once in the hospital, hemodynamically stable patients with unstable pelvic fractures would undergo either an X-ray or enhanced contrast CT scan depending on the suspicion of hemodynamic and pelvic fracture stabilities. Please refer to the text for better understanding.

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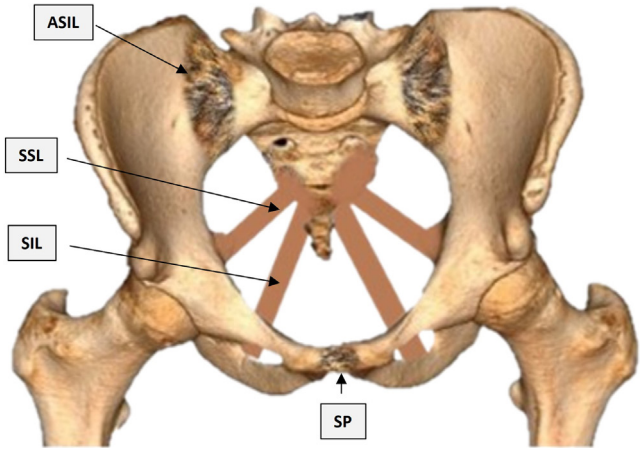

Figure 2

Human pelvis is constituted by the two iliac bones and the sacrum. Posteriorly the two iliac bones are articulated together by an arthrodial synovial joint, and by strong ligaments: short ligaments (iliolumbar and sacroiliac – anterior (ASIL) and posterior) and long ligaments (sacro-sciatic ligament (SSL) and sacro-ischial ligament (SIL)). Anteriorly both iliac bones are directly joined together in the symphysis pubis (SP) by an amphiarthrosis joint with potent fibrocartilage with strong ligaments fixing the two iliac bones.

ligaments tend to dilacerate, while the anterior ones are preserved (Figs. 3 and 4); on the other hand, anterior short ligaments and, under more severe trauma, long ligaments, tend to dilacerate in cases of anteroposterior traumatism, with preservation of the posterior short ligaments (Figs. 3 and 4). Long ligaments can dilacerate when more displacement in anteroposterior traumatism occurs. Classically, it is said that if the symphysis pubis separates itself apart more than 2.5 cm, long ligaments must necessarily be damaged; however, this is not a rule (1). In vertical C-type fractures, all ligaments are injured (Figs. 3 and 4). Nonetheless, either full luxation or partial subluxation of the posterior sacroiliac joint is very infrequent compared with iliac fracture with or without sacral bone fracture. In any case, a combination of luxation and fracture is not unfrequent.

There are very important vital structures within the pelvic cavity which, in case of lesions, can provoke major bleeding or abnormal visceral function, and even peritoneal or retroperitoneal contamination. Main vessels rarely are injured, but retropubic or presacral vascular plexuses can be damaged when one or both hemipelvises separate apart or displace vertically from each other, making traction on the vessels.

Diagnosis

Hemodynamic stability diagnosis is essential in any type of pelvic fracture, mainly in those after high-energy trauma, as it is the most important acute life-threatening risk. Clinical hemodynamic parameters include heart rate and blood pressure. A sustained systolic blood pressure of less than 80–90 mm Hg after treatment with vasoactive drugs is considered a sign of active bleeding (2), whereas in the presence of a heart rate of more than 100–110 beats per minute in a traumatized patient, it can be considered that there is hemodynamic instability. These parameters can be complemented bedside with assessments of mental status, face pallor, or capillary refill (normal before 2 min) (3, 4).

Some other hemodynamic parameters include stroke volume – the volume of blood pumped out of the left ventricle of the heart during each systolic cardiac contraction: average stroke volume of a 70 kg male is 70 mL, cardiac output – the blood volume the heart pumps through the systemic circulation over a period measured in liters per minute, and total peripheral resistance (3, 4). Blood tests for coagulation status, lactate, and some other parameters are also very useful for the detection of hemodynamics and inflammation (2).

In many cases, although it is considered that the patient does not have hemodynamic instability, there may be a risk of having an occult bleeding source that potentially will cause later instability. Therefore, prompt diagnosis requires identifying a possible bleeding origin and pelvic fracture type. For bleeding detection in stable patients, an immediate one-stage contrast-enhanced CT scan is the appropriate diagnostic test (2). Planar CT images are enough to make a proper and accurate diagnosis; however, 3D pelvis images may be useful for inexperienced staff (5). If a CT scan can be performed in the emergency room, a complete diagnostic test can be obtained in a few minutes.

In pelvic CT scan, radiation is always an issue. CT scan is a major source of radiation, which is always a major concern. While a chest X-ray exposes the patient to 0.01–0.1 mSv, an abdominal CT scan exposes them to 10–20 mSv, with the threshold for elevated risk of neoplasia being 100 mSv per year (6). According to the literature, 20–40% of patients end up with negative scans, which, apart from the radiation effect on the patient, results in a waste of resources and time (7). In a study performed in the Radiology Department of our hospital, even more than 60% of CT studies for polytrauma showed no abnormal bleeding. The easier it was to perform the study, in terms of shorter time, and the more rotation the staff has, the more cases of negative results will be shown in CT scan images (Fig. 5). Therefore, simple X-rays should be considered in cases of hemodynamically stable patients where there is reasonable suspicion of no unsafe bleeding. Anyhow, the key line indicating when a patient should undergo a contrast-enhanced CT scan or just an X-ray study of the pelvis is very difficult, and basically relies upon the anamnesis, the clinical examination, and the blood test outcomes, provided blood test results can be obtained very fast. Nonetheless, in many cases of patients with high-energy trauma, anamnesis becomes very difficult, and in cases of doubt, surgeons prefer performing a contrast CT scan.

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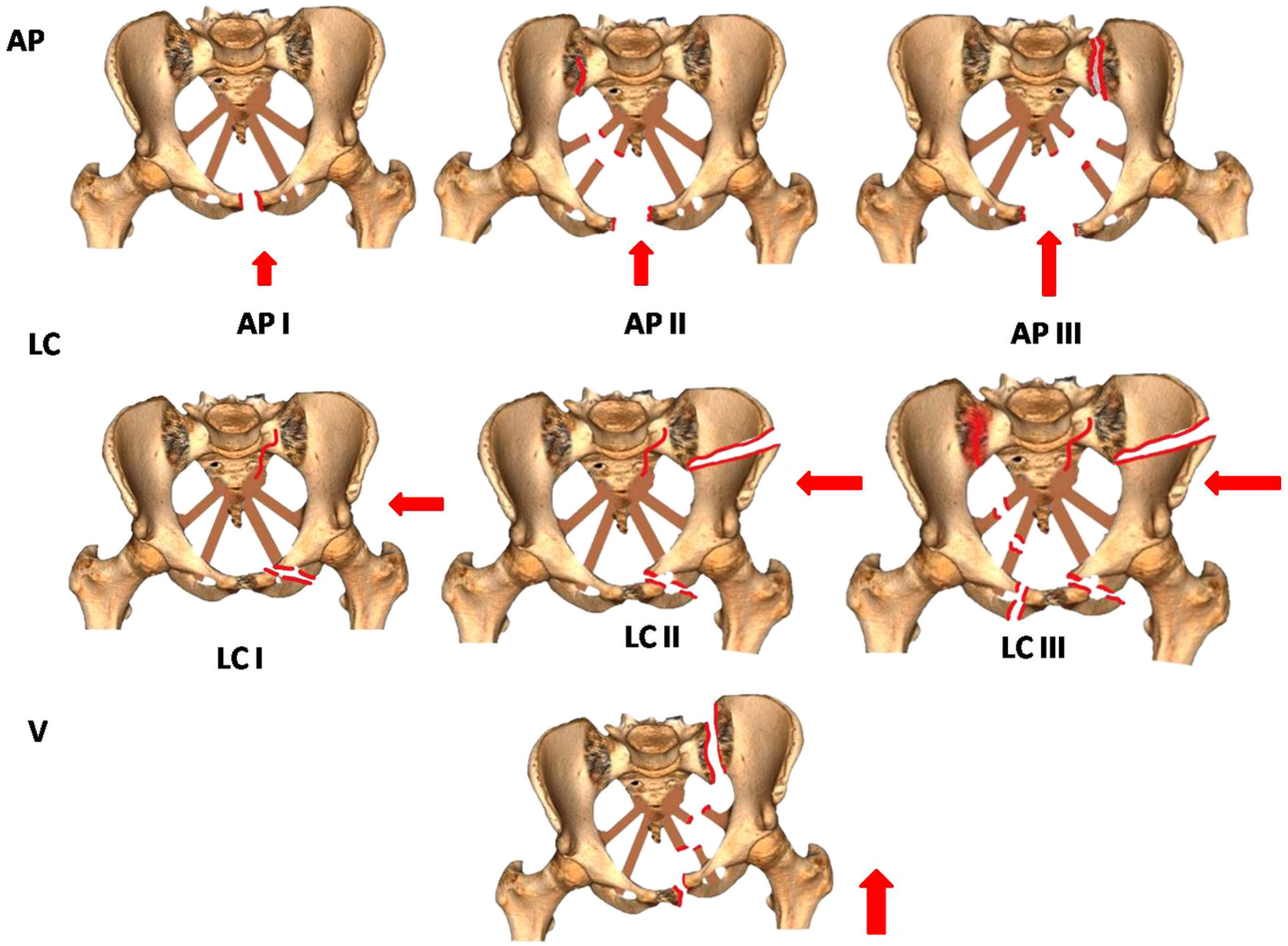

Figure 3

Young and Burgess classification of pelvic fracture. (APC) Fractures after anteroposterior compression traumatism. APC I: stable pelvis. Pure anterior diastasis <2.5 cm. Some, but not all, anterior sacroiliac and symphysis pubis ligaments must be damaged; long ligaments are intact. APC II: rotationally unstable, vertically stable. Pubic diastasis >2.5 cm, anterior disruption of sacroiliac ligaments, and diastasis of the anterior part of the sacroiliac joint, with intact posterior sacroiliac ligaments; long ligaments are disrupted. APC III: complete disruption of pubis ligaments >2.5 cm; disruption of anterior and posterior sacroiliac and long ligaments; rotational instability with vertical instability but no ascension of the iliac bone. (LC) Fractures after lateral compression traumatism. LC I: Stable pelvis. Oblique or transverse fracture of pubic rami with ipsilateral anterior compression fracture of the ala sacra. LC II: rotationally unstable, vertically stable fracture. Fracture of pubic rami with posterior fracture with dislocation of the ipsilateral iliac wing (crescent fracture). LC III: rotationally and potentially vertical unstable fracture. Ipsilateral lateral compression with contralateral anteroposterior compression (APC); this fracture is also called windswept pelvis, commonly due to an automobile rollover mechanism. (V: vertical shear) Fractures after vertical traumatism. This is the most severe rotationally and vertically unstable fracture with a higher risk of bleeding and mortality. Combined fractures are possible. The higher risk of bleeding is either the combination of a lateral external rotation (AP) with a vertical shear fracture or a bilateral vertical shear (V).

CT scans in pediatric patients should be more restrictive as the risk of radiation-associated cancer is higher (8). In adult patients, after performing a CT scan, we never complete the study with inlet or outlet projections in the acute clinical setting, but always for follow-up without a CT scan, provided the patient evolves well without pain.

Classification

Pelvic fracture classification is essential because there is an association between the injury mechanism, the fracture displacement, and hemodynamic stability.

The Young and Burgess classification aims to predict that correlation (Fig. 3). It divides the fracture mechanism into three types: lateral, anteroposterior, and vertical traumatisms. Since lateral compression closes the pelvic ring, the risk of presacral and retropubic vascular plexus laceration is very low, so bleeding is not expected to be severe; on the other hand, in the anteroposterior trauma, one or both hemipelvises open apart from each other, and the vascular plexuses can dilacerate depending on the strength of the injury force and the subsequent acute pelvic deformity. Vertical traumatisms provoking a pelvic fracture are nearly systematically followed by major bleeding.

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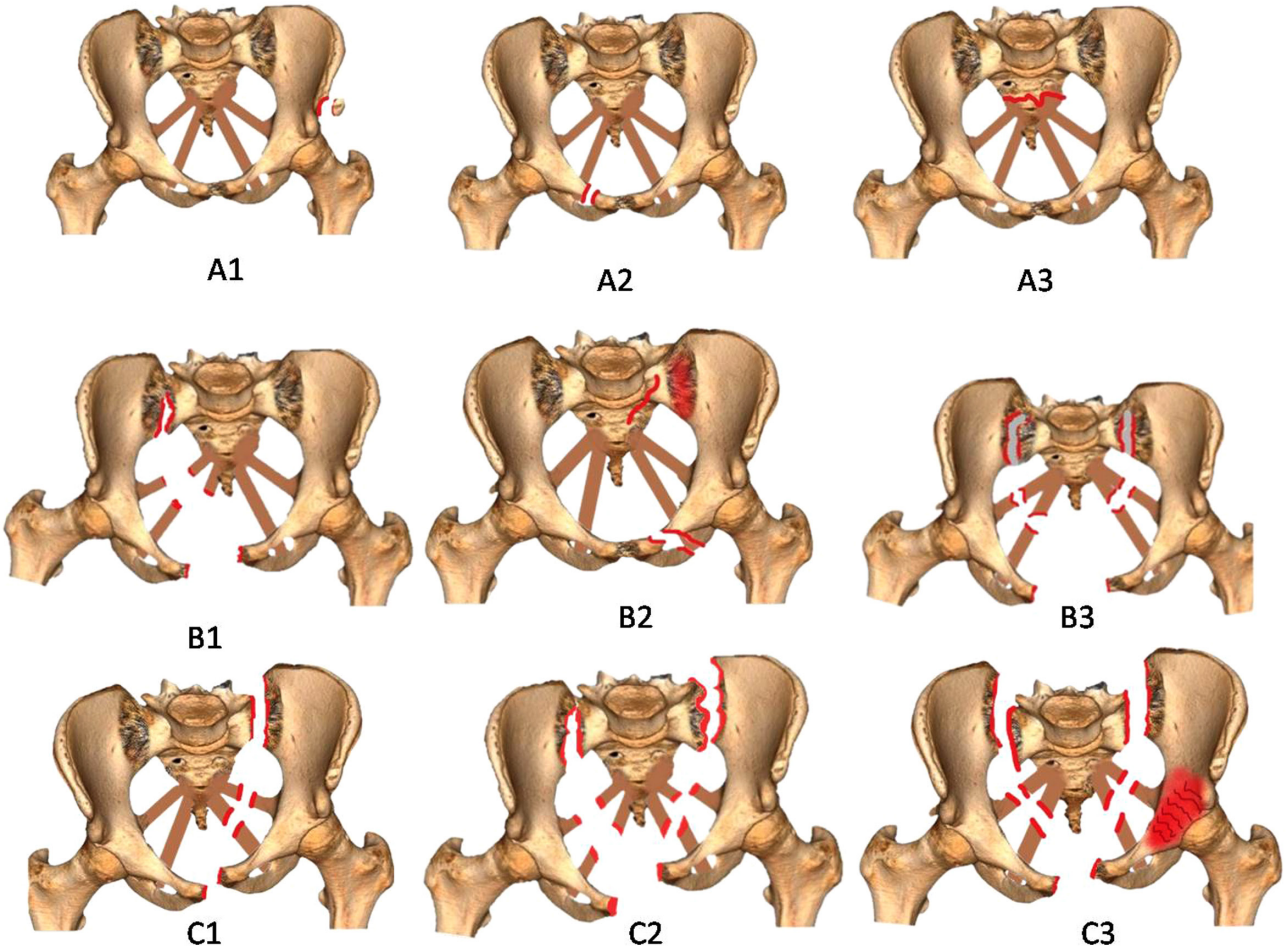

Figure 4

Tile-AO classification of pelvic fracture. A-type: fractures not affecting the biomechanical structure of the pelvis, not involving the ring. Rotationally and vertically stable. B-type: fractures with incomplete disruption of the posterior arch. Rotationally unstable and vertically stable. B1: open book-injury (external rotation). B2: lateral compression fractures (internal rotation). B2-1: ipsilateral anterior and posterior fractures. B2-2: contralateral (bucket-handle) injuries. B3: bilateral fractures. C-type: vertically unstable fractures. C1: unilateral, C2: bilateral with one side type B and the other side type C, and C3: bilateral.

The AO-Tile classification (9) (Fig. 4) is based on the idea that for pelvic stability, the posterior sacroiliac joint of the pelvic ring is much more important than the anterior one. Basically, this classification is very similar to Young and Burgess's and considers three types of fractures: type A (no pelvic instability), type B (rotational instability but vertical stability), and type C (rotational and vertical instability). Type B fractures are subdivided into two groups: lateral compression (by lateral trauma, closing the pelvis, like that with the same denomination in Young and Burgess classification) and open book (by anteroposterior traumatism). Therefore, the prognoses of risk for bleeding are similar for the corresponding groups of both classifications. Type A fractures should not have a major bleeding risk. Type B fractures, whether caused by lateral compression or unilateral fracture by anteroposterior trauma but with not so much deformity (usually less than 2.5 cm of opening), should not have a high bleeding risk either, whereas unilateral (with more than 2.5 cm of opening) or bilateral type B fractures caused by anteroposterior trauma, and mainly type C fractures, would eventually provoke hemodynamics instability, although type B fractures might be easy for reduction by closing the ring early.

Young and Burgess, as well as AO-Tile classification, can be described just with an AP X-ray and completed with inlet and outlet projections (Figs. 6 and 7). Therefore, as mentioned earlier, the decision for either an X-ray or CT scan is in surgeons' hands, depending on the suspicion of major bleeding with a subsequent risk for hemodynamics.

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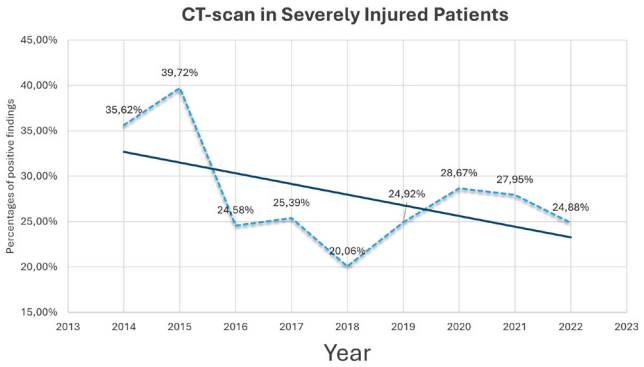

Figure 5

Frequency of full-body CT scan per year for polytrauma patients prescribed by the emergency room of our hospital. The easier to perform the study was, in terms of shorter time, and the more rotation the staff had, the more cases of negative results were shown in CT scan images (from 39.72% in 2015 to 24.88% in 2022). Protocols had to be changed.

Immediate pelvis stabilization

Immediate pre-hospital stabilization

A pre-alert call by the pre-hospital team to the emergency room of the receiving hospital is very valuable (10, 11, 12, 13). Mortality rates vary depending on the type of fracture and concomitant injuries; it has improved significantly over the last decades due to rapid on-site intervention (2, 14, 15). Pelvic binder use should be standard in high-impact blunt trauma patients, independently of the trauma mechanism (16). In a survey carried out by the Société Internationale de Chirurgie Orthopédique et de Traumatologie (SICOT) trauma committee in 2022 among 358 surgeons from 80 countries, pelvic binder use for pre-hospital treatment was nearly the rule (17). However, in a study performed in The Netherlands in 2023, the helicopter emergency medical services pre-hospital sensitivity of unstable pelvic ring injury assessment and non-invasive pelvic binder device application rate was very low (18). The decision to set a binder in any pelvic traumatism until a proper diagnosis is established, is reinforced by the fact that the value of clinical assessment to identify major bleeding is very limited (13).

Figure 6

Inlet X-ray projection shows anteroposterior displacement of iliac bones. No abnormalities can be seen in this case with the binder on.

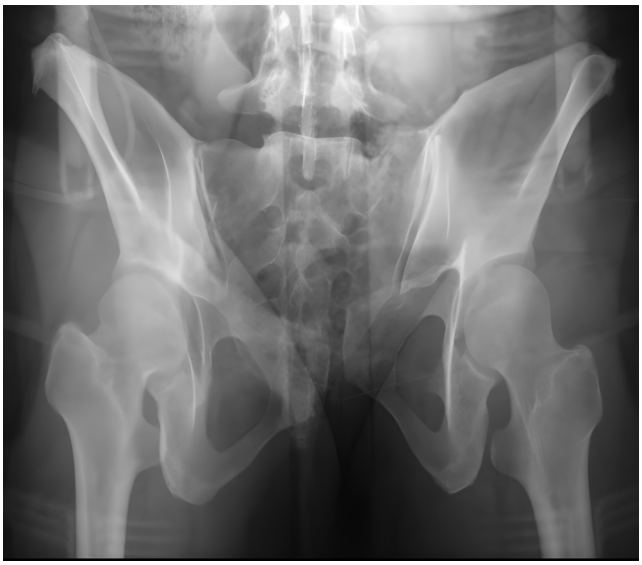

Figure 7

Same case as in Fig. 6. Outlet projection shows vertical displacement of iliac bones. Vertical displacement of the left hemipelvis can be seen with the binder on. The binder closes the pelvic ring.

The Société Française d'Anesthésie et de Réanimation (SFAR) Guideline panel provided 22 statements on pre-hospital and hospital management of the unstable – or suspected to be unstable – patient with pelvic fracture in the first 24 h, including pre-hospital stabilization. Surgeons considered that patients aged over 65 have a higher risk of death than younger patients. In the pre-hospital setting, external circumferential compression onto the pelvis should be applied as soon as possible in case of severe pelvic trauma suspicion, with a binder placed onto the greater trochanters, and patients should be transferred to a 'Trauma Center' (12) (Figs. 8 and 9).

Immediate stabilization with a binder

Closing the pelvic ring as a first immediate step for bleeding control and pelvis fracture stabilization is widely agreed upon (2). The use of pelvic binders, a non-invasive technique that dramatically reduces mortality rates, is currently considered the gold standard for pelvic ring closure (2, 19). Therefore, this approach

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Figure 8

Pelvic binder in a correct position.

should be taken in acute situations whenever the pelvic ring diameter is enlarged. Moreover, binders can be applied rapidly and simply, allowing for the transfer of X-rays or CT scans with the pelvic ring closed (20).

Should the pelvis not have an instability in the emergency room, a binder is not harmful, although it can provoke skin sores if maintained for more than 2–3 days (2, 21, 22). Radiological studies should preferably be performed under pelvic binder stabilization. Nonetheless, if there is a suspicion that the pelvis has an unstable fracture (either anteroposterior or vertical injury mechanism), the binder should be released just during the time of CT scan performance, once the patient is positioned to start the test. It is not infrequent to miss an open-book fracture due to an anteroposterior mechanism when the X-rays or the CT scan are performed with the binder on (Figs. 10 and 11).

Figure 9

Pelvic binder in an incorrect position.

In any case, when used, the binder should always be neatly positioned onto both greater trochanters, as they can provide circumferential compression to the true pelvis and never above the symphysis pubis; otherwise, it can provoke abdominal compression, increasing venous pressure and subsequently provoking further bleeding (Fig. 9). During the time the binder is in place, legs, if possible, should be kept together with feet in internal rotation.

Immediate stabilization with external fixation

External fixation offers better pelvic stability than binders, avoids abdominal compression or skin necrosis (22), and allows for laparotomy (2, 23) (Fig. 12). Nevertheless, quick stabilization is very important (24, 25, 26), and external fixation is not so advisable for immediate stabilization because it is much more time-consuming and aggressive than binders, does not stabilize the posterior arch of the pelvis ring, must be applied by an orthopedic surgeon, and requires anesthesia and an operating room. External fixation has nearly its unique indication as an immediate method of stabilization in the case of open fractures, and in the closed ones when scheduleding for definite osteosynthesis prolongs because of the patient's general condition. External fixation can be changed from a binder once the acute setting has stabilized, and it can also be set up after embolization in patients in whom hemodynamic instability is not resolved and requires a longer time in the intensive care unit.

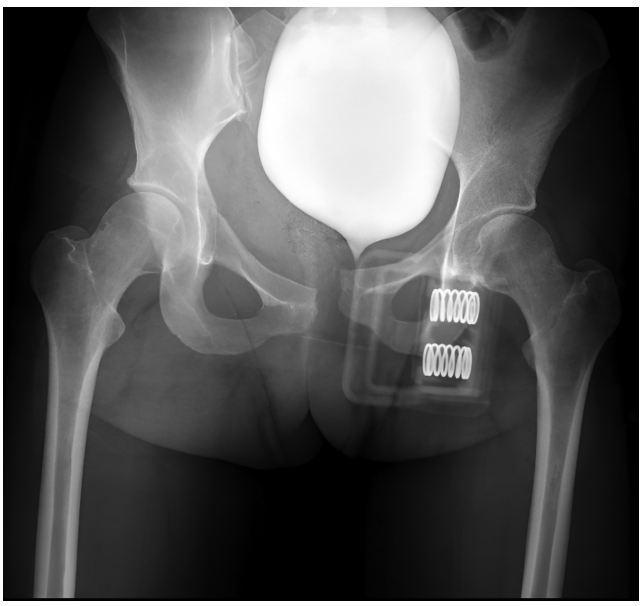

Figure 10

Pelvis after anteroposterior traumatism with the binder on. No pubic diastasis can be seen.

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Figure 11

Same case as in Fig. 10, without the binder. A diastasis of the symphysis pubis can be seen with an increase in the diameter of the true pelvis.

Pin placement should never be in the iliac crest as purchase is very poor and can loosen because the iliac wing is too thin for that (Fig. 13). Conversely, insertion above the hip joint, at the height of the anteroinferior iliac spine, is very robust and needs only one 5–7 mm-diameter pin on each side. This supracetabular insertion also allows the frame construct to be placed at the height, or even below, of the symphysis pubis, leaving the abdomen free if laparotomy is needed (Fig. 12).

Figure 12

External fixation in a correct position. With a supracetabular positioning of pins strong purchase is obtained, and a laparotomy, if necessary, can be easily performed.

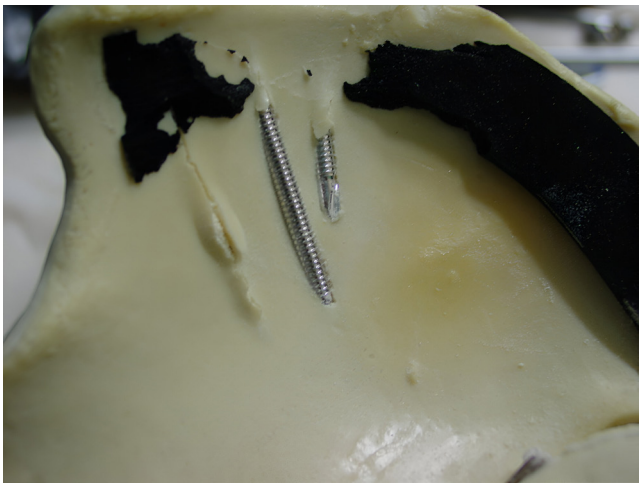

Figure 13

External fixation with incorrect pins anchorage in the iliac crest (artificial bone). Iliac wing is too thin for proper pin anchorage and the chance of weak pin purchase is very high.

Posterior pelvic lesions cannot be firmly stabilized by anterior external fixation frames (2). C-clamp fixators are designed for that; it is an immediate tool for posterior pelvic ring area stabilization, to be used when a pure sacroiliac dislocation or a sacral fracture exists (27). This device provides compression of the iliac bone to the sacrum and therefore closes the sacroiliac dislocation. Reduction and fixation using a C-clamp require the iliac bone to be intact. On the other hand, descension until the reduction of the iliac bone in some cases of C-type fractures may be difficult, particularly in obese or muscular patients. In these cases, longitudinal leg traction together with pelvis fixation with a C-clamp may be of help, and in very unstable fractures, it should be maintained even with the combination of an anterior frame (Figs. 14 and 15).

Although the C-clamp allows for embolization, pelvic packing, laparotomy, and other techniques, the correct positioning of its pins may be difficult and can cause iatrogenic complications even when the method is applied by an experienced surgeon (28, 29); the main complications reported in this respect are migration into the pelvic cavity, which can provoke intestinal piercing or further bone fractures (Fig. 16). Since C-clamps cannot be used if the iliac bone is harmed, and proper positioning may be even more difficult in the immediate clinical setting when the patient is in the emergency room in a supine position, it is used by a large number of surgeons. In any case, a binder is as efficient as a C-clamp, and whenever possible, a binder should be the choice (12, 17).

Indications for external fixation with just an anterior frame are unilateral or bilateral open book fractures (B1 or B3), whereas a C-clamp must be added in case of C-type fractures, provided the iliac bone is not fractured.

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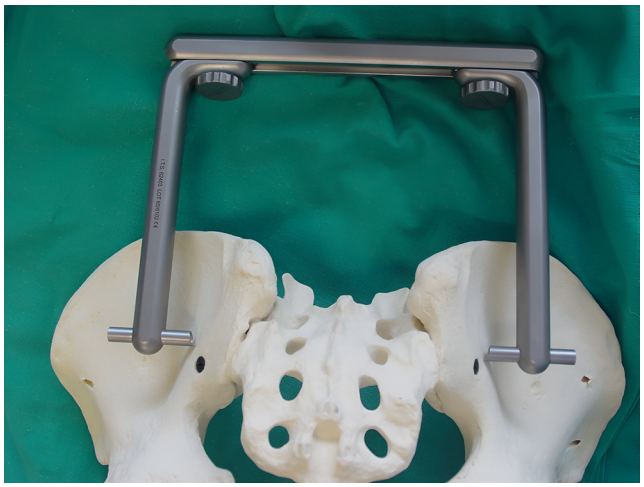

Figure 14

C-clamp in the correct position (artificial bone).

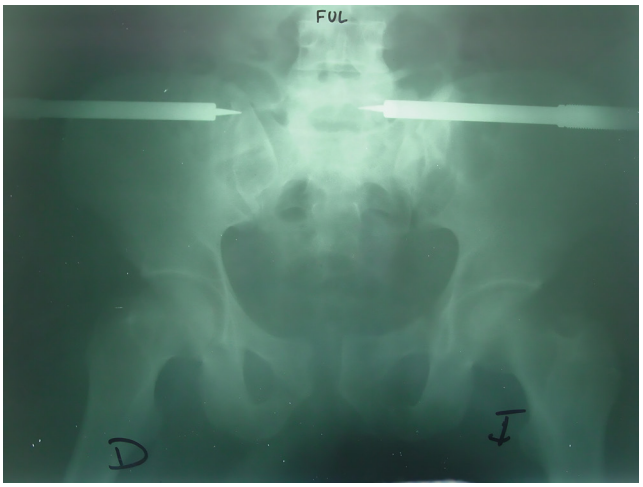

Figure 16

C-clamp. Medial migration of the left pin.

Immediate stabilization with transiliac-transsacral screws

The time to definitive posterior arch fixation has decreased during the last decade (30). Nowadays, just after admission when a proper diagnosis is made, immediate percutaneous sacroiliac screw insertion for unstable pelvic fractures produces excellent technical results (2, 31) (Figs. 17–22). It has the advantage that it is also a definitive treatment. However, this requires a highly skilled surgeon and a fracture pattern in which the iliac bone preserves its integrity. Definitive surgery within 72 h usually seems safe regarding the risk of reoperation, other adverse events, and mortality (32), but acute transiliac-transsacral screws can shorten this time.

Mobile C-arms are essential for C-clamp and for the transiliac-transacral screw technique. Surgeons

Figure 15

C-clamp in a hemodynamically stable patient after laparotomy.

Figure 17

Clinical aspect of an open sacral fracture after a fall from a palm tree in a hemodynamically stable patient.

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Figure 18

Same patient of Fig. 17. CT scan: 'split' fracture of the sacrum.

need to be trained and educated to ensure correct technical conduct and interpretation of radiographs. Intraoperative 3D imaging using special CT scan 3D (6) offers better visibility and much easier surgery performance, but it is not available in every hospital and, if so, not always in the operating theater. Being intraoperative CT scan a better tool, radiation is a significant issue for patients and surgeons.

In conclusion, in the survey carried out by the SICOT trauma committee, CT scan was used by 93%, most trauma surgeons use a routine pre-hospital pelvic binder, external fixation was the standard method of acute fixation, and ilio-sacral screws were the most used technique for definitive fixation, but not as immediate treatment (17). Having a well-trained surgeon on call in any hospital that promptly performs accurate fixation is

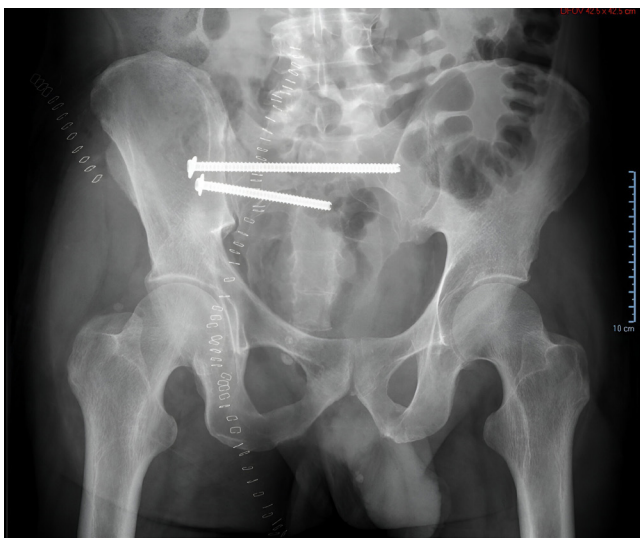

Figure 19

Same patient of Fig. 17. Immediate transiliac-transacral screws.

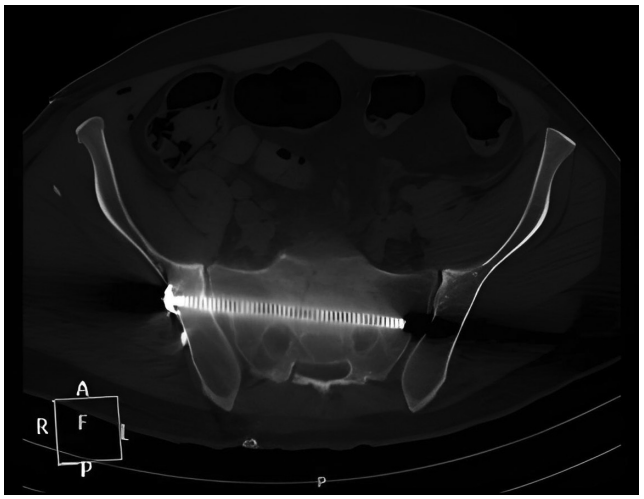

Figure 20

Same patient of Fig. 17. Postoperative CT scan. Proximal transiliac-transacral screw.

very rare, although in the case of pelvic fractures and hemorrhagic shock, it may be critical (33).

Immediate stabilization of open pelvic fractures in stable patients

A pelvic fracture is considered open when the fractured bone has communication with the outside or with a viscus that has it (vagina, rectum, urethra, etc.). As in any other open fracture, a broad-spectrum antibiotic should be administered as early as possible, preferably within 1 h after the accident (34). There are currently protocols for pre-hospital administration of cefazolin in the pre-hospital phase (34, 35).

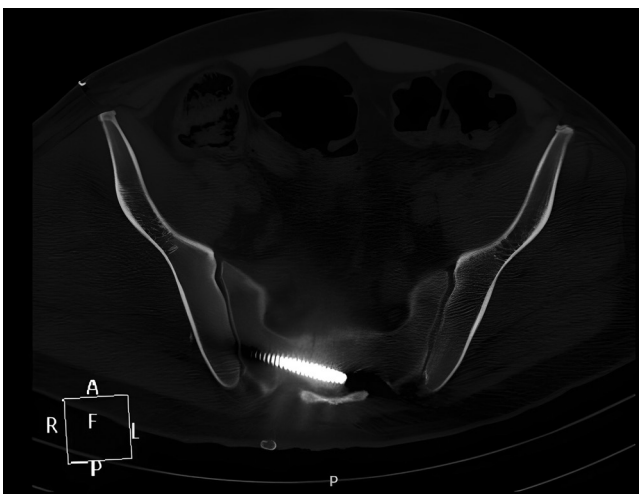

Figure 21

Same patient of Fig. 17. Postoperative CT scan. Distal transiliac-transacral screw.

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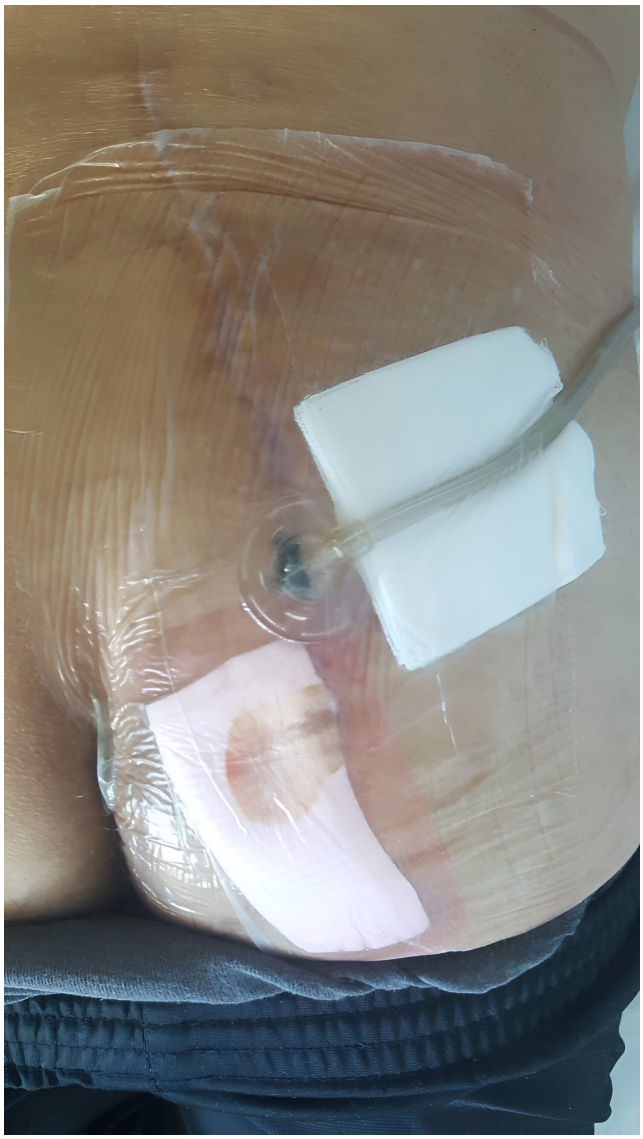

Figure 22

Same patient of Fig. 17. Good evolution of the wound during the treatment with a vacuum system.

Immediate repair of open fractures depends on their nature. Most of the open pelvis high-energy fractures have concurrent hemodynamic instability; however, some of them may occur with normal blood and circulation course. In these cases, immediate osteosynthesis can be performed, provided that simple surgery, such as iliosacral screw, is suitable for good stability achievement (Figs. 17–22).

Intraperitoneal bladder injuries usually need surgical repair, whereas extraperitoneal lesions can be managed nonoperatively by treating them with a transurethral catheter. Concern for pelvic hardware contamination is one of the most common reasons for repairing extraperitoneal bladder injuries, but some authors believe that extraperitoneal should not affect the decision about open fracture surgery (36).

Anorectal trauma is present in more than 30% of open fracture cases and may need fecal diversional colostomy. If the entry point for transiliac-transsacral screw placement is not compromised, immediate bone stabilization can be performed in these cases. Although no studies have been published on complications reduction when doing so, being osteosynthesis an isolated variable in unstable pelvic fractures with a stable patient, it is known that in cases of more severe open fractures with hemodynamics instability, resuscitation therapy together with treatments of associated injuries, soft tissue management, and osteosynthesis remain essential for the reduction of mortality and improved outcomes (37).

In open pelvic fractures, regional injury classified according to Wang *et al.* (38) – perineal (type I), ilioinguinal (type II), sacroiliac (type III), composite (type IV) – definite osteosynthesis with transiliac-transacral screw of simple fractures in the sacroiliac region can be performed as contamination risk appears manageable (Figs. 17–22).

Elderly patients

There is an increasing number of elderly patients who sustain severe injuries even after a low-energy mechanism; it could represent 40% of all trauma admissions by 2050. These patients have low tolerance to the initial trauma, to early fragility and undertriage, and to special diagnostic and therapeutic protocols (39). Bleeding is always a problem, even more severe in elderly patients, particularly in those on anticoagulant medication. Careful triage and treatment considering the peculiarity of senescence is essential. The surgical aspects of the immediate treatment are conducted under the same conditions as in other patients. A binder and, if possible, iliosacral screwing are the two desirable techniques in hemodynamically stable patients.

Pregnancy

Pelvic traumatism during pregnancy requires different emergency diagnosis and treatment protocols, as fetal and maternal risks are higher not only because of the trauma but also due to radiation. If necessary, at least an urgent diagnosis with conventional views is required, and potential deleterious effects must be assumed. If possible, an X-ray should be the unique guide for diagnosis and treatment but, if needed, a CT scan should be performed, with interdisciplinary assessment being essential (40).

Medication

Considering that in case of pelvic fractures, any substance administered to a patient by any route is

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a medicament, we should contemplate many, either related to bleeding, pain control, or pH regulation, apart from some others for different variables. Since that would require a lengthy discussion, in this paper, we consider only some related to patients hemodynamically stable: pain control (analgesia), bleeding control medicaments (tranexamic acid), and blood reposition (allogenic blood transfusion).

Analgesia

Pain is an important issue in pelvic fractures. Whereas paracetamol plus the addition of opioids may be the choice for low-energy fractures, dose-adjusted intravenous morphine is needed in high-energy trauma (34, 41). Pain control also changes depending on the general condition of the patient.

Tranexamic acid

According to a consensus document by the British Orthopaedic Association, patients with a pelvic fracture should be given intravenous tranexamic acid (TAi), ideally within 1 h after injury, to treat or prevent excessive blood loss (19). In a recent review by the Cochrane Database of TAi compared to placebo, it was shown that, with low-certainty evidence, the administration of TAi reduces the risk of demanding an allogeneic blood transfusion up to 30 days. Nonetheless, no difference in all-cause mortality was shown. Likewise, little or no difference was seen in relation to the risk of death from any cause, as well as the number of people who experience a heart attack or stroke. There is no evidence about the impact of TAi on the risk of deep vein thrombosis, pulmonary embolism, or reactions to it. There is no evidence of the use of topical TA. So far, there is no strong evidence of bleeding reduction by any medicament in the case of pelvic fracture, either open or closed (42).

Allogenic blood transfusion

The need for allogenic blood transfusion in unstable pelvic fractures is very frequent; it does not mean that patients are hemodynamically unstable, but hemoglobin levels are always diminished. However, it has been shown that in those patients receiving early transfusion and at least one surgical intervention for hemorrhage control, mortality increases by up to 30%. However, in those patients sustaining pelvic angioembolization, mortality is reduced (43).

ICMJE Conflict of Interest Statement
The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of this study.

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Compliance with ethical requirements
This study has been conducted after approval by the Institutional Review Board of the Hospital Universitario Costa del Sol, Universidad de Malaga, Spain.

Author contribution statement
EG designed the study, established the methods, wrote the first draft of the manuscript, obtained the ethical approval for human analyses, and revised the final version. JRC selected the clinical cases, prepared the figures, discussed, and approved the final version. JMB collected data, discussed on the manuscript, revised the edition, discussed on the manuscript, and approved the final version. AR-R searched for bibliography and revised the manuscript. All authors fully contributed intellectually to the completion of the study.

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