REVIEW ARTICLE

Management of recent unstable fractures of the pelvic ring. An update Conference supported by the Club Bassin Cotyle. (Pelvis-Acetabulum Club)

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Summary Traumatic injury to the pelvic ring is a result of high energy trauma in young patients. These osteo-ligamentous injuries are associated with numerous lesions including retroperitoneal hematoma, urogenital, cutaneous and neurological (lumbosacral plexus). The goal of initial management is to restore vital indicators, urinary excretion function and protect the patient from infectious complications. An emergency decisional algorithm helps manage haemodynamic instability. Initial bone and ligament procedures should reduce displacement and make it possible for the patient the wait until his condition is stable enough for definitive surgical fixation. The goal of surgical treatment is to avoid nonunion and malunion. Stable fixation of the posterior arch after reduction favors union. Different techniques can be used by the posterior, anterior ilio-inguinal or lateral percutaneous approaches. Anterior fixation is discussed to improve reduction and increase the stability obtained with a posterior procedure. Anterior external fixation is useful to temporarily reinforce posterior stabilization. © 2013 Published by Elsevier Masson SAS.

Introduction

Unstable pelvic ring injuries are defined as life-threatening with a loss of pelvic ring stability, which transfers axial skeletal loads to the two lower extremities. Since the first historical descriptions on the Napoleonic battlefields (Larrey) and the precise description in the treaty by Joseph François Malgaigne (Bailliere, Paris 1847), numerous studies have clearly described these lesions [1], their mechanisms [2] and their horizontal and vertical instability as well as rotational instability on the sagittal plane [3,4]. Although surgical fixations were attempted in the past, conservative treatment was the treatment of choice, until external fixation techniques were developed [5,6]. Modern fixation techniques propose more or less invasive anterior and posterior solutions.

The aim of this conference is to provide an update on existing methods of management of pelvic ring injuries. We will not study the epidemiology, the mechanisms, the diagnosis or the classification of these osteoarticular injuries, which were described in the Sofcot 2006...
conference: "Fractures and disruption of the pelvic ring in adults" [7].

Management of a life-threatening situation: "damage control"

Pelvic ring injuries are known to cause a retroperitoneal haematoma, which may be life-threatening. In a personal series of 2064 cases at the French Alps Trauma Centre, we identified 135 unstable lesions (6.5%) with 28% out of these were the cause of haemorrhagic shock upon arrival.

Initial management

The principles of Advance Trauma Life Support (ATLS) place the control of hemorrhage in third place (C) after freeing the airways (A) and restoring ventilation (B) [8]. There are numerous causes of bleeding: venous, osseous and arterial.

Management should begin at the scene of the accident. All high energy trauma or falls from a height should suggest pelvic injury. Larrey’s maneuver (pushing on both iliac spinous processes), causes lower lateral lumbar pain and suggests a diagnosis. Pre-hospital management should therefore include compression of the retroperitoneal space by pulling together the two coxal bones. A belt (Fig. 1) or a sheet wrap using the Seattle technique [9] (Fig. 2) prevents expansion of the retroperitoneal haematoma, and the loss of several precious hemoglobin grams.

Upon admission into a regional reference center, external compression should be continued until the patient undergoes a general and morphological examination. A simple AP X-ray of the pelvis should be performed, which shows displacement and clearly shows anterior and posterior injuries. All injuries to the pelvic ring are potential causes of haemorrhagic shock. The clinical symptoms which should alert the surgeon and the intensive care specialist are pulse acceleration, which occurs after a loss of 750 mL of blood, then an increase in diastolic pressure and anxiety after 1500 mL of blood loss. Hemostasis and filling maneuvers should be begun in the presence of these symptoms.

There are no anatomo-pathological lesions that provide a prognosis for bleeding. Only iliac wing and transfominal sacral fractures may cause more bleeding.

In a haemodynamically unstable patient, fast-echo ultrasound identifies the importance of retroperitoneal or intraperitoneal bleeding. If the patient is haemodynamically stable enough, a body scan will identify active arterial bleeding and angiography with embolization may be indicated.

The use of a compression belt for more than 6 hours is difficult due to compression of the greater trochanters and the risk of bedsores. This should be replaced by transcondylar traction to reduce elevation of the hemi-pelvis and place a pelvic clamp using the Ganz technique [10]. This is only effective if the iliac wing is intact. It is effective in sacro-iliac disruptions and sacral fractures. It also allows access to the abdomen and the groin (arteriography). These external reduction maneuvers should be performed in a shock control unit and should not interfere with rapid multidisciplinary management with CT scan, angiography or surgery. This compression maneuver and stabilization of the posterior bone lesion is nevertheless the pre-requisite before performing interventional vascular X-ray. The indication for clamping is not an osteoarticular injury but hemodynamic instability.

During angiography the terminal branches of the internal iliac artery are explored: ilio-lumbar artery, lateral sacral artery, superior gluteal artery, internal pudendal artery [11]. Embolization is performed with material that is resorbable after 6–12 hours. This may involve leaving a catheter in place to perform additional embolization in case...
pelvis + hemorrhagic shock (ATLS C)

HOSPITAL

Management of recent unstable fractures of the pelvic ring

![Diagram](image)

Figure 3 Algorithm for management of a haemodynamically unstable patient with a pelvic ring injury.

of repermeabilization of embolized vessels or hemostatic disturbances.

In cases of extreme shock ("in extremis"), an endoaortic balloon occlusion may be performed by femoral route immediately above the aortic bifurcation to stop the bleeding. In this case the angiographic examination is performed below the occlusion and arterial lesions are embolized [11].

Direct hemostasis by retroperitoneal surgery has been suggested by a German group [12]. This includes a risk of worsening the hemorrhage from release of the compartmental syndrome which develops due to abdominal wall tension from bleeding. This may nevertheless be a salvage technique in a patient if embolization or intra-aortic balloon occlusion are impossible to perform.

Different algorithms have been proposed for the management of unstable pelvic fractures (Fig. 3).

The role of the orthopedic specialist is to help reduce the active bleeding. Displaced bones can be reduced by transcondylar traction for stabilization of the fracture site. Compression of these borders is obtained by clamping. The clamp stops intrafocal bleeding and lowers the volume of the pelvic compartment where the haematoma is.

No definitive treatment of osteo-ligamentous lesions should be proposed during the acute phase. This is orthopaedic "damage control". If the patient cannot receive definitive treatment after 5 days, the clamp should be replaced by an external fixator, which is associated with fewer cutaneous complications. The most effective device for posterior fixation is the trapezoid compression frame by Slatis et al. [4], with a double anterior bar. However the vertical stability of this device is not sufficient and transcondylar traction should be maintained until definitive treatment with internal fixation can be performed.

Management of urogenital injuries

This step corresponds to the letter D of the ATLS procedure to manage deficits. The examination should look for mental bleeding, urinary retention or dysuria. Investigation of the urethra by contrast enhancement can be performed with a urogenital catheter, with a 600 cc syringe with a conic tip (gavage syringe) filled with contrast medium. If there is filling without any leaks gentle catheterization can be performed. Catheterization can be performed immediately if there are no suspicious clinical signs. A large diameter catheter is preferable. Catheterization is performed without guide. If there is any blockage this maneuver should be stopped. In that case a supra-pubic catheter is recommended.

Injury to the urethra is not suggested by any specific anterior pelvic arch injury. On the other hand, a highly displaced fracture on the ilio-pubic ramus can easily cause injury to the bladder if it is full. Management differs depending on whether there is a lesion of the intraperitoneal bladder, which should be rapidly sutured, or a subperitoneal lesion, which should be drained. Repair of the urethra is usually performed later, once peri-urethral injuries have healed (2 months).

Open fractures of the pelvic ring

Cutaneous injuries correspond to the letter E of the ATLS procedure. The life-threatening risk of pelvic ring fractures is doubled in case of an open fracture [13]. These may include Morel-Lavallée lesion with cutaneous necrosis, an anorectal or an inguinal lesion. Faringer’s stages of severity [14] can be used in these cases (Fig. 4).

A high colostomy at the transverse colon can divert fecal matter, simplify care and obtain perineal healing in Faringer’s zone 1. A high colostomy allows ilio-inguinal access to the pelvic ring, in case anterior fixation is needed later on.

Morel Lavallée degloving lesions with cutaneous necrosis are frequent in Faringer peritrochanteric zone 3. Debridement and continuous draining is sometimes necessary. Lavage should be repeated regularly. Healing by continuous aspiration is useful in the acute phase (VAC therapy).

Indications for early definitive treatment of osteo-ligamentous injuries

Multiple trauma patients present with a systemic inflammatory response syndrome (SIRS), which begins after the first day and ends after approximately 4 days. After 10 days the Compensatory Anti-inflammatory Response Syndrome (CARS) develops, reducing the patient’s immune defenses against surgery [15]. Thus the patient should undergo
surgery either before the first day or between the 4th and 10th days. The decision should be based on systemic stability of the patient based on a temperature of above 34°C, an absence of acidosis with a PH of above 7.2 (normal lactate) and the absence of coagulopathy with fibrinogenemia above 1 g/L. [16]. These stable patients may benefit from early definitive osteo-ligamentous treatment ("early total care") immediately following admission into a reference center.

**Treatment of osteo-ligamentous injuries**

The goal of treatment of osteo-ligamentous injuries is to reduce and stabilize injuries to the posterior and anterior arches of the pelvic ring by internal or external fixation.

**Fixation of posterior arch injuries**

**Analysis of lesions**

***Topographic analysis.*** A precise description of the topography of injuries helps decide on the type of fixation. The descriptions of Letournel (Fig. 5) [1], Denis (Fig. 6) [17] and Day (Fig. 7) can be used [18].

Isolated sacral lesions are not considered pelvic ring injuries. They have been described by Roy-Camille and Strange-Vogensen [19,20].

Sacral fractures were classified within the group of pelvic ring lesions by Letournel and Denis into three types [1,17]: extra-foraminal or Denis 1, foraminal or Denis 2 and intraforaminal or Denis 3. Fixation should take into account any incarceration of the roots of the lumbosacral plexus in the fracture site for Denis 2 and 3 fractures. No compression should be applied to the fracture site. Any eventual sacral malunion can be tolerated if it is less than 1 cm of vertical ascension [21].

Sacro-iliaic disruption destroys any possibility of union between the sacrum and the coxal bone. It can be partial or full (crescent fracture).

Crescent iliac fractures are classified according to Day [18]. The iliac fracture is seen as crescent shaped on simple AP view X-rays. These lesions correspond to sacro-iliaic disruption, which leaves a posterior fragment of the iliac wing in the sacrum. Day Type 2 includes a tear in the anterior inferior sacro-iliaic ligaments, a vertical fracture line in the iliac joint and preservation of the interosseous ligament. In Day type 3 fractures the sacro-iliaic joint is completely separated, with a tear from back to front in the anterior and inferior sacro-iliaic ligaments, a tear in the interosseous ligaments, a vertical extra-articular iliac fracture line, which is extremely posterior leaving only the postero-superior and postero-inferior iliac spines inserted into the interosseous ligament. Day type 3 fractures do not involve the sacro-iliaic joint. The vertical iliac fracture line is immediately in front of the joint. The interosseous ligament is intact (Fig. 7).

Iliac fractures rupture the posterior pelvic arch between the sacro-iliaic joint and the acetabulum. A pelvic clamp does not help these fractures.

***Analysis by mechanism.*** Young and Burgess have described three mechanisms for these fractures: antero-posterior compression, lateral compression and vertical shearing as well as mixed mechanisms (Fig. 8) [2].

***Analysis according to instability.*** Sacro-iliaic lesions can be incomplete with horizontal instability alone because of the intact interosseous ligament (Tile type B), or complete with vertical instability (Tile type C) (Fig. 9) [3]. They require perfect reduction to obtain satisfactory ligament healing. Incomplete reduction is not well tolerated.

Sacral injuries usually present as Tile type B instability, which is incomplete and horizontal. When there is antero-posterior or vertical translation in a sacral fracture site, the lesion is complete, Tile type C [3]. There is secondary stability due to impaction of the fracture. Without reduction the result is malunion. Iliac lesions all present with vertical instability.

**Types of fixation**

Three types of internal fixation are proposed: anterior plate by ilio-inguinal approach, open or guided (fluoroscopy, fluoro-navigation, CT guided), percutaneous sacro-iliaic screw fixation and finally posterior fixation.

***Posterior fixation.*** Reduction of a sacral fracture requires a posterior approach with the patient in the prone position. Fixation can be obtained with a plate, bolts, sacro-iliaic screws or a system of sacro-iliaic lumbar fixation. The two
ends of the curved ilio-iliac plate are placed on the external posterior iliac wings. The middle part of the plate is behind the sacrum on a subcutaneous path [22,23]. With bolting, two subcutaneous threaded bars are placed behind the sacrum which pull together and stabilizes the fracture on the washers placed on the external posterior iliac wing [3]. Lumbar-sacro-iliac fixation uses pedicle screws in L4 and L5 and screws in the posterior iliac spine joined by spinal rods [24]. After open reduction of the fracture, sacro-iliac screws stabilize the fracture until union. To reduce the size of the incision necessary for reduction, the sacro-iliac screw can be inserted percutaneously by a lateral counter incision.

Reduction of sacro-iliac disruption can also be performed by posterior approach.

Screw fixation of a type 2 Day fracture should be performed with the patient in the prone position. Screws are inserted at the level of the posterior superior and posterior inferior iliac spines. The trajectory ends between the two
tables of the iliac wing from back to the front. Threaded cancellous bone screws 7.3 mm in diameter and 32 mm long attach and stabilize the fracture.

Iliac fractures can be approached from behind by remaining exo-pelvic. Two iliac plates are inserted.

The posterior approach can only be used in stabilized patients, after acute SIRS has resolved. The most severe complication is postoperative infection of the surgical site in a patient in the supine position. Reduction can be difficult in the prone position, because of anterior iliac pressure, which pushes the coxal bone back towards the sacrum. Reduction is controlled by a finger on the pelvis inserted at the tip of the greater sciatic notch [25].

**Anterior fixation.** The anterior ilio-inguinal approach approaches the sacro-iliac joint at the window between the external iliac vessels medially and the iliac-psoas muscle laterally. The sacrum cannot be approached anymore than 1 cm inside the joint. Anterior fixation is only possible in stabilized patients. Nevertheless the supine position is well tolerated. This position facilitates reduction of sacro-iliac disruption by placing posterior pressure on the posterior iliac spines. Reduction is stabilized by sacro-iliac plate fixation or sacro-iliac screws inserted through a lateral counter incision. Day 1 type crescent fractures [18] and fractures of the iliac wing are also reduced and stabilized by ilio-inguinal approach. There are very few infectious postoperative complications. The main risk of this approach is medial mobilization of the lumbosacral trunk with superior gluteal nerve compression.

**Sacro-iliac screw fixation.** Sacro-iliac screw fixation is frequently used. It was proposed by Lambotte [26] in 1913 and was extensively reported by Letournel [25]. In the US, intraoperative observation of placement of one or two sacro-iliac screws has been performed by Pennal’s fluoroscopic views, [27]. In 1995, Mayo and Routt, proposed percutaneous screw fixation with the patient in the supine position [28]. The lateral view is essential to control the path of the screw. The transili-sacral screw crosses the iliac wing, the sacro-iliac joint, the sacral wing, and the dense cancellous vertebral body of S1 (Fig. 10).

The ideal indication is sacro-iliac disruption. After reduction, the screw causes stabilization with the head of screw, which is raised with a washer, pressing on the external surface of the coxal bone and threaded screw, which has been screwed in the body of S1.

Type 3 Day fractures are also an indication.

In sacral fractures, screw fixation provides partial vertical stabilization. Fully threaded screws should be used to avoid compression and prevent injury to the sacral roots or the lumbosacral trunk, which can be incarcerated into the fracture site.

The most severe complications are iatrogenic damage to the lumbosacral trunk and the root of S1 due to extra-osseous trajectories. This risk is increased in the presence of incomplete reduction of displaced fractures. This is why initial management during "damage control" should focus on reducing any displacement. External maneuvers by posterior pressure and manipulation of the coxal bone are performed to obtain perfect reduction before screw fixation. Fluoro-navigation reduces radiation to the patient and the healthcare team. Guided screw fixation can also be facilitated by intraoperative CT scan. Only non-displaced fractures can be stabilized by CT scan in interventional radiology [29].

Stability of isolated ilio-sacral screw fixation is mediocre. It depends on the quality of fixation of the distal threads in the body of S1. Several authors have suggested using two screws. However, the second screw increases the risk of an extra-osseous trajectory.

Usually sacro-iliac screwing is completed by anterior fixation. Although this can favor posterior reduction, for example in the case of disruption of the pubic symphys, fixation of the anterior arch should be performed first (Fig. 10).

**Fixation of lesions of the anterior arch**

**Analysis of the lesions**

Letournel has proposed a descriptive analysis [1]. This includes lesions of the pubic symphysis, the pubis, the obturator ring (ipsilateral controlateral and bilateral iliio-sciatic and ilio-pubic rami), of the anterior acetabular wall and the iliio-sciatic ramus and transverse acetabular fractures.

Pennal and Garside have proposed an analysis of the mechanisms of pelvic injury [30]:

- lateral compression (B1) causes fractures of the obturator foramen with either a controlateral lesion to the posterior lesion or an ipsilateral lesion. They can also result in para-symphyseal lesions with injury to the two obturator foramen/mina which extend more or less to the pubic symphysis or with an overlap of the two symphyseal joint surfaces. A so-called "tilt" fracture may also occur which results in a vertical iliio-pubic ramus, which is separated from the anterior acetabular wall and the interface between the iliio-pubic ramus and the pubis. This can result in compression of the external iliac vessels and cause difficulties giving birth in case of malunion;
- anterior-posterior compression ("open book" or Tile B2) opens the pubic symphysis. When the opening is less than

**Figure 10** Fixation of a sacro-iliac disruption with a compression screw between the external surface of the coxal bone and the vertebral body S1. Reduction of the symphysis is maintained by a reinforced cranial plate. Symphyseal fixation is performed first to favor posterior reduction.
2.5 cm (B.2.1), the sacro-sciatic and sacro-tuberos ligaments are intact. When the anterior opening is more than 2.5 cm (B.2.2), these ligaments are torn;

- shearing (Tile C) usually results in symphyseal lesions [3]. The Isler and Ganz, alphanumeric code classification includes a third figure [4]. Lesion x.i.i.1 includes lesions that are solely anterior ipsi- or controlateral. Lesion x.i.i.2 includes multiple lesions that may be uni- or bilateral symphyseal or para-symphyseal. Lesion x.i.i.3 includes associated injury to the acetabulum, a fracture to the anterior wall or a transverse fracture.

**Indications for anterior fixation**

According to Bruce et al. [31], the risk of secondary displacement of incomplete posterior lateral compression sacral fractures (Tile B1.1) is nearly 0%. In complete posterior sacral fractures it is 17% in case of association with an anterior controlateral fracture; 24% if it is ipsilateral and 68% if it is bilateral. Anterior fixation is especially indicated in the latter fractures (Fig. 11).

In type B.2 fractures associated ligament injuries and rotational displacement of the hip on the sagittal plane must be taken into account. B.2.2 with an opening of more than 2.5 cm are unstable and require anterior fixation, like B.2.3 lesions with sagittal rotation. The differential diagnosis between a type B.2.1 and B.2.2 fracture can be difficult when the diagnostic X-ray is performed on a pelvis that has been reduced by external fixation. Dynamic X-rays, with separation of the iliac wings are useful in this case.

Types B3 and C are unstable and require anterior fixation. The work of Bruce et al. [31] can be taken into account to adapt the indication for anterior fixation if this is difficult. In these cases:

- the stability provided by the obturator membrane and bed rest should be used as much as possible;
- the stability of the posterior fixation plays a role in this indication. The more stable the posterior fixation is, the less anterior fixation is indicated.

**Types of fixation**

*Fixation of the pubic symphysis.* This involves one special anterior plate, with median reinforcement, four or six holes, and a Pfannenstiel type anterior approach. This technique can also be used with symphyseal disruptions associated with uni- or bilateral para-symphyseal fractures. Fixation of the
Ilio-pubic rami is not necessary, the obturator membrane creates stability. **Ilio-pubic fractures.** The direct approach to ilio-pubic fractures is ilio-inguinal. **“Tilt fractures”** require this approach to obtain anatomical reduction.

The screw fixation technique for these fractures is original. It is performed percutaneously by fluoroscopic guidance from back to front with an iliac point of entry. External fixation such as a pelvic clamp can also be used with a supra-acetabular rod on either side. The connection between the two rods is obtained with two crossed stems. This fixation removes pressure from any posterior fixation.

The “‘In-fix’” method proposed by Starr [32] involves placing a supra-acetabular “‘tulip’” type pedicle screw (a screw used for spine surgery) on each side. The two screws are connected by a subcutaneous stem. This system thus creates an anterior clamp similar to that of the external fixation of the same name, but it is internal fixation. This external fixation and the “‘In-fix’” system are for temporary fixation, which is removed once bone union is obtained.

**Postoperative course**

The postoperative course depends upon the time necessary to obtain bone union and ligament repair before weight bearing can begin.

A 90° seated position solicits the posterior arch of the pelvic ring and should be avoided for at least 45 days. We prefer the seated in bed position at 45°, for 45 days.

Once the incision has healed the patient can be moved during hydrotherapy.

One hundred percent full weight bearing on both legs is not allowed until 3 months after surgery. Unilateral weight bearing does not protect the pelvic arch because it creates asymmetric loads, which tend to deform the pelvic ring.

Recommended times until weight bearing are approximate and depend upon the patient’s physical condition. They can be reduced when the patient is young and increased in older patients, smokers or patients with co-morbidities.

**Complications of treatment**

Iatrogenic neurological complications due to an extra-osseous sacro-ilac screw trajectory are severe. The position of the screw must be changed. They result in sequelae such as drop foot and neuropathies with long-term functional deficits [33]. When compression screw fixation was performed in a sacral fracture, the clinical examination may reveal a postoperative deficit. In this case the path of the nerve roots should be confirmed on CT scan and a mobile fragment should be looked for. The screw should be changed for a fully threaded screw and neurolysis of the lumbosacral trunk or the root of S1 is performed depending on the deficit.

Infectious complications of the posterior incision require debriding-lavage and intravenous antibiotics.

Secondary displacements may occur due to defective fixation, and are usually anterior. Revision surgery is usually necessary to reinforce the system. A sacro-ilac screw may be too short or may not be screwed far enough into the body of S1. The anterior clamp is then a temporary, non-surgical solution to reinforce stability in a weak patient.

**Managing sequelae**

There are several types of sequelae that affect the functional prognosis: urogenital, neurological, nonunion, malunion.

**Urogenital sequelae**

Genital dysfunction is underestimated if it is not specifically look for. This may include retrograde ejaculation, impotence, and painful intercourse due to vaginal dryness. They are the consequence of anterior vascular lesions and lesions to the neuro-vegetative system. The pre-sacral pudendal plexus may be involved.

The approach is pragmatic with the use of Sildenafil (Viagra) in men as a therapeutic test. If medical treatment fails a penile implant is indicated.

Urethral stricture may develop in men, which is usually due to catheter trauma. Repeat dilations are performed in this case.

**Neurological sequelae**

Initial neurological lesions are present in 52% of these cases [33]. At the 20-month follow-up, there are severe neurological lesions in only 14% with a motor deficit in less than 3/5. They result in neuropathic pain in L4-L5 (lumbosacral trunk) and S1. Sacro-ilac pain must be distinguished from incomplete reduction.

During the acute phase, neurolysis of the lumbosacral trunk by ilio-inguinal approach is only proposed to relieve compression of a bone fragment. Usually there is no visible compression and treatment is symptomatic with an anti-epileptic such as Pregabalin (Lyrica). The prognosis of these lesions is poor when they involve deficits that are secondary to sacro-iliac disruption causing nerve root avulsions. During sacral trauma the lumbosacral plexus branches are injured. The prognosis is better in these cases with spontaneous recovery [34]. A spinal stimulation implant may be a solution for debilitating nerve root avulsion.

**Nonunion/pseudarthrosis**

Nonunion of the pelvic ring is not well tolerated. It may occur due to insufficient fixation or premature mechanical loading. A history of co-morbidities and tobacco use also favor this outcome.

Surgical revision may be necessary, usually without attempting reduction if nonunion is associated with malunion [35,36]. In that case, fixation must be reinforced, usually with plates, and especially in the anterior arch (Fig. 11).

In case of sacro-ilac pain because of non-healing of the sacro-ilac and ilio-lumbar ligaments, arthrodesis is proposed. The results of these arthrodeses, whatever the technique are disappointing. The best treatment of
nonunion is preventive and based on the quality of management of initial fixation [36].

Malunion

Malunion is usually due to insufficient reduction of sacral lesions. It is fairly well tolerated. Vertical displacement of less than 1 cm of the sacrum does not lead to functional deficits [21]. Reduction of a sacro-iliac malunion is dangerous for the lumbosacral plexus. Arthrodesis without displacement reduction is preferable [35].

Conclusion

Pelvic ring injuries require initial multidisciplinary management whose goal is to stop or limit life-threatening bleeding. Early pre-hospitalization compression, the use of clamps and embolization has changed the life-threatening prognosis. Before osteo-ligamentous lesions can be treated they must be evaluated, and various classifications have been published for this purpose.

Sacro-iliac screw fixation simplifies treatment. It is only possible on a pelvis that has been reduced in the early stages of management. The fixation technique should be rigorous to prevent iatrogenic lesions. The indication for anterior stabilization should be large, especially if the chosen posterior fixation does not control horizontal instability or sagittal rotation stability. This initial treatment strategy can prevent nonunion and malunion.

Disclosure of interest

The author declares that he has no conflicts of interest concerning this article.

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